Sept. 12, 1933. J. R. KELLEY 1,926,902

RADIOGRAPHIC APPARATUS

Filed March 28, 1928 3 Sheets-Sheet 1

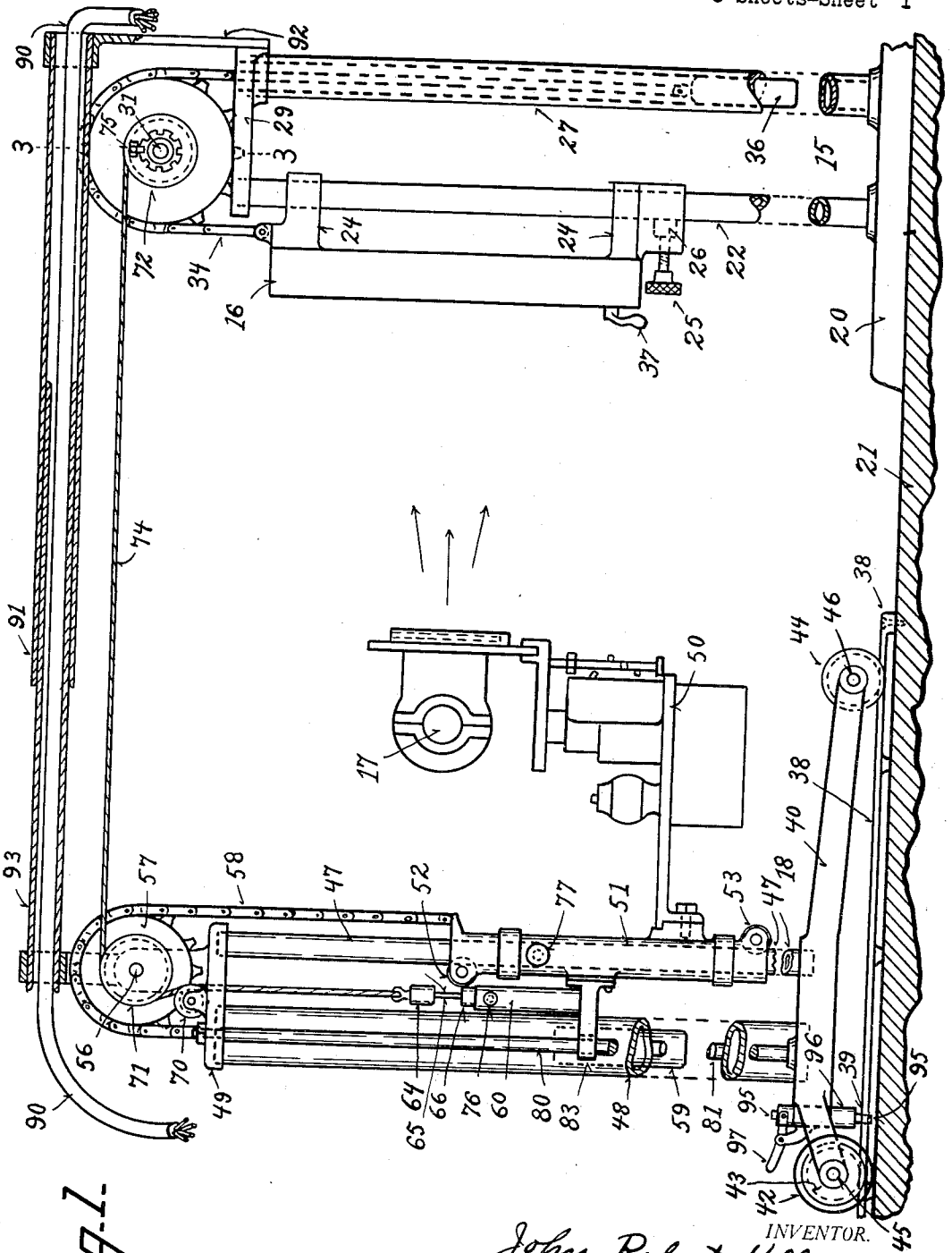

Fig. 1.

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RADIOGRAPHIC APPARATUS

Filed March 28, 1928 3 Sheets-Sheet 2

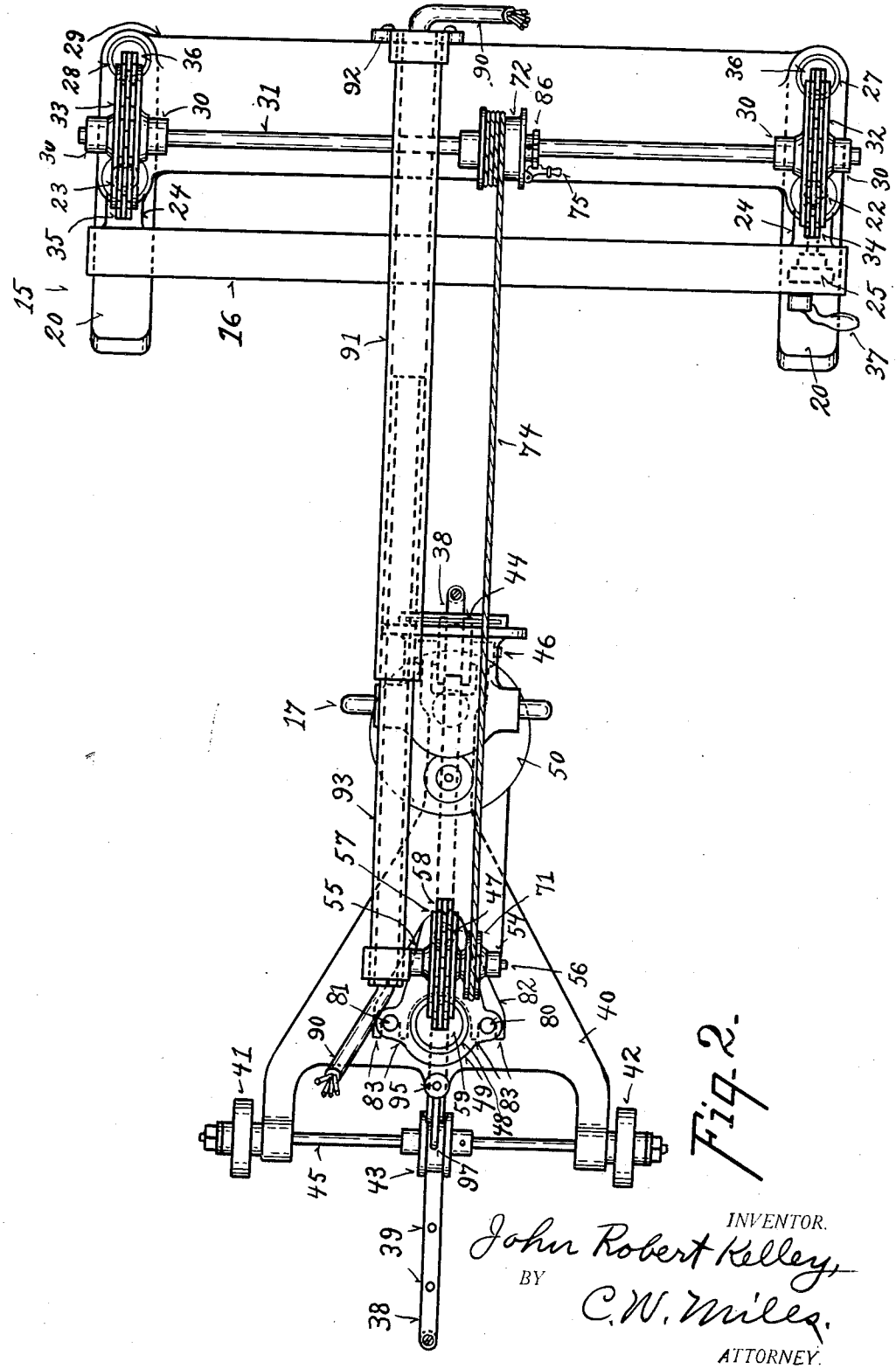

Fig. 2.

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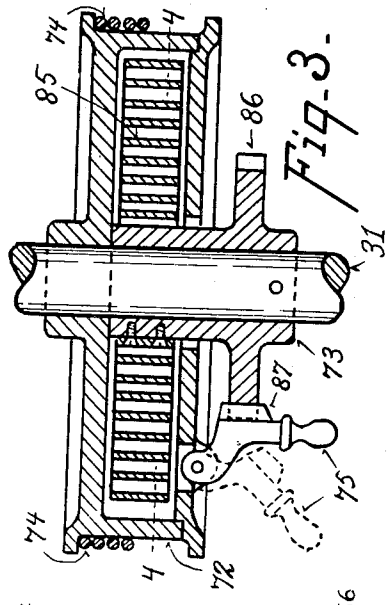

Fig. 3.

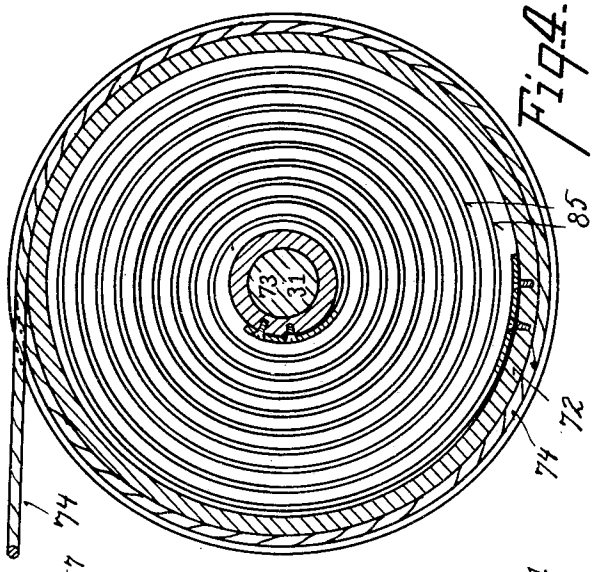

Fig. 4.

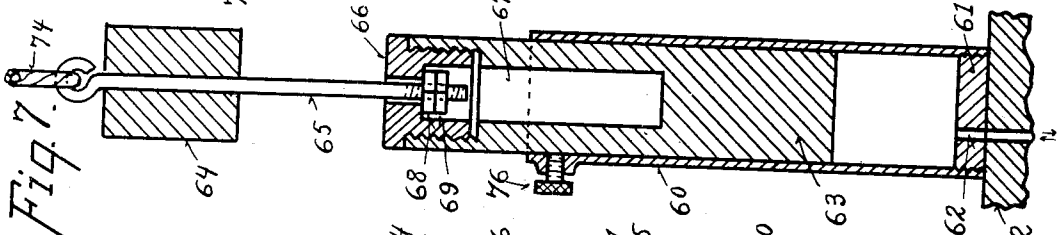

Fig. 7.

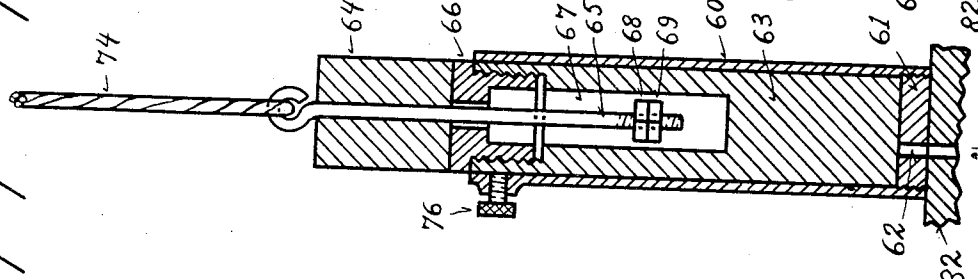

Fig. 6.

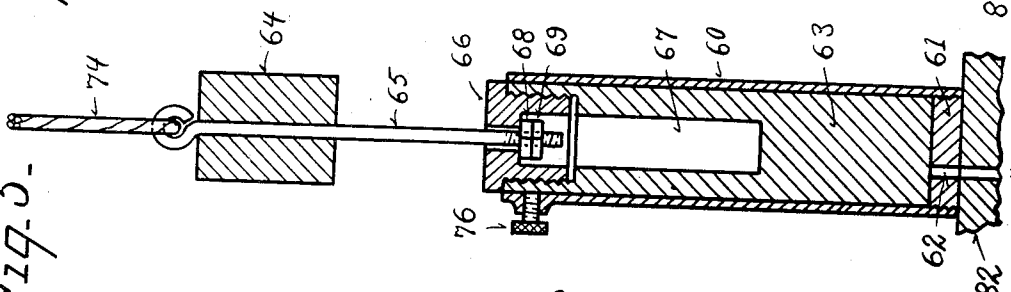

Fig. 5.

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UNITED STATES PATENT OFFICE

1,926,902

RADIOGRAPHIC APPARATUS

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Application March 28, 1928. Serial No. 265,293

6 Claims. (Cl. 250—34)

My invention relates to improvements in radiographic apparatus. One of its objects is to provide improved connecting and counterbalancing means whereby the sensitive plate holding apparatus may be adjusted to different heights by the operator and the X-ray generator or tube with its supporting means will automatically follow the movement of the plate holder either upwardly or downwardly and come to a rest in position to project X-rays centrally upon the sensitive plate carried by the plate holder. Another object is to provide improved means whereby the X-ray generator may be conveniently adjusted either to or from the plate holder. Another object is to provide for adjusting the X-ray generator to or from the plate holder without materially disturbing the mutual counterbalancing of the X-ray generator and the plate holder or the automatic movement and centering of the X-ray generator relative to the plate and plate holder. Another object is to provide improved counterbalancing and actuating mechanism connecting an X-ray generator to a plate holder. My invention also comprises certain details of form and arrangement and combination of components, all of which will be fully set forth in the description of the accompanying drawings, in which:

Fig. 1 is a side elevation of a radiographic apparatus embodying my improvements.

Fig. 2 is a plan of the apparatus illustrated in Fig. 1.

Fig. 3 is a sectional detail taken on line 3—3 of Fig. 1.

Fig. 4 is a sectional detail taken on line 4—4 of Fig. 3.

Figs. 5, 6, and 7 are sectional details of a portion of the counterbalancing and compensating apparatus.

The accompanying drawings illustrate one embodiment of my invention in which 15 represents a stationary framework upon which is mounted and counterbalanced a plate holder cabinet or carriage 16, which is adapted to be freely and readily adjusted vertically to bring the cabinet 16 to any desired height relative to a patient or subject standing or sitting between the cabinet 16 and an X-ray tube or generator 17, which is also vertically adjustable upon and relative to a tube supporting standard 18.

The framework 15 comprises a base 20 to rest upon the floor of a room 21. Projecting upwardly from the base 20 are two tubular members 22 and 23 which serve as vertical guides for the plate cabinet 16. The cabinet is provided with rearwardly extending projections 24, which are bored to fit the tubular members 22 and 23 and serve as sleeves to slide vertically upon the members 22 and 23. A set screw 25 is threaded into one of the projections 24 and at its inner end bears upon a soft metal plug 26, which when forced by the screw 25 into contact with the member 22 serves to lock the cabinet to its adjusted position upon the members 22 and 23. Projecting upwardly from the base 20 are two tubular members 27 and 28, preferably of larger diameter than the members 22 and 23. A plate or cross-bar 29 is attached rigidly to the upper ends of the tubular members 22, 23, 27, and 28 to form therewith and with the base member 20 a strong rigid framework for the support and guidance of the plate cabinet 16.

The plate 29 is provided with journal bearings 30 in which is journaled a shaft 31. Sprocket wheels 32 and 33 are mounted rigidly upon the shaft 31. Sprocket chains 34 and 35 are supported upon and in driving relation to the sprocket wheels 32 and 33. At one end the sprocket chains 34 and 35 are attached pivotally to the upper edge of the cabinet 16. At their opposite ends the sprocket chains 34 and 35 are attached to counter weights 36 which are housed within the bores of the tubular members 27 and 28, and move up and down therein whenever the cabinet 16 is moved vertically. The weights 36 are proportioned so as to accurately counterbalance the weight of the cabinet 16 and members carried thereby, so that when the set screw 25 is released an operator may place his hand upon the hand lever 37 attached rigidly to the cabinet 16, and move the cabinet 16 up or down to any desired position with small effort, and with practically no noise, lost motion or vibration either of the cabinet or the supporting frame 15. The cabinet will thus remain at any position to which it may be adjusted.

It has been customary heretofore to mount X-ray tubes at a fixed distance from the plate cabinet, it is however desirable to vary the distance between the X-ray tube and the plate cabinet, and I have devised improved reliable and efficient means whereby the tube may be quickly and readily adjusted to and from the plate cabinet, in which 38 represents a track attached rigidly to the floor 21, and preferably provided at intervals with perforations 39 to receive a spring bolt to lock the X-ray tube supporting apparatus to said track at relatively different distances from the plate cabinet. The tube supporting apparatus comprises a base 40 which is

provided with extended arms to which are journaled a series of rollers 41, 42, 43, and 44. The rollers 41 and 42 are located upon opposite sides of the track 38 and rest upon the floor 21. The rollers 41 and 42 are mounted loosely upon the ends of the shaft 45. The roller 43 is preferably but not necessarily employed, and is a grooved or flanged roller to ride upon and be guided along the track 38, and is mounted rigidly upon the shaft 45. The roller 44 is a grooved or flanged roller mounted loosely upon a shaft 46 carried in the forked end of the base member 40. Tubular members 47 and 48 project upwardly from the base member 40. A cap member 49 is rigidly attached to the upper ends of the tubular members 47 and 48, whereby the base 40, tubular members 47 and 48 and cap member 49 together constitute a strong rigid framework for the support of the X-ray tube. The X-ray tube is mounted either rigidly or adjustably upon an X-ray tube carriage 50, which has a sleeve 51 which slides vertically upon the tubular member 47, and is provided with antifriction rollers 52 and 53 to assist in the noiseless and vibrationless movement of the X-ray tube carrier 50 upon the tube 47.

Vertical tie-rods 80 and 81 extend parallel with and upon opposite sides of the vertical tube 48. A bracket 82 is rigidly attached to the sleeve 51 and is provided at its rear end with forked projections 83 embracing the tie-rods 80 and 81 to guide the X-ray tube carriage 50 in its movements and prevent said carriage moving rotatably upon the tube 47.

The cap member 49 is provided with journal bearings 54 and 55 in which is journaled a shaft 56. A sprocket wheel 57 is mounted rigidly upon the shaft 56. A sprocket chain 58 is mounted upon the sprocket wheel 57. One end of the sprocket chain 58 is attached to the upper end of the sleeve 51. The opposite end of the sprocket chain 58 is attached to a counter weight 59 which is housed within the tubular member 48, and moves vertically therein when the X-ray tube carriage is moved vertically upon the tubular member 47. The weight 59 is slightly more than sufficient to counterbalance the weight of the X-ray tube carriage and members carried thereby.

In order to accurately counterbalance the weight of the X-ray tube carriage and members carried thereby, and to cause the X-ray tube carriage to automatically move up and down in unison with the movements of the plate cabinet, I provide a thin walled metal housing 60 having its lower end closed by means of a plug 61 and provided with a relatively restricted air vent 62. The casing 60 is attached rigidly to the bracket 82 of the X-ray tube carriage 50 and moves therewith. A counterbalancing weight 63 fits snugly within the casing 60, and is adapted to move vertically therein, thereby causing a current of air to enter or leave the space below the weight 63 within the casing 60 through the air vent 62, due to the fit of the weight 63 being close enough to the inner face of the casing 60, so that all the air required for displacement of the weight 63 cannot be supplied between the weight and the wall of the casing 60, and thereby causing the air to form an air cushion below the weight when the weight is descending into the casing 60 and to create a partial vacuum within the casing 60 when the weight is lifted rapidly therein. Above the weight 63 is a supplemental weight 64 connected to the weight 63 by means of a connecting rod 65 which enters through a perforation in the cap 66 of the weight 63 into a chamber 67 within the weight 63. Lock-nuts 68 and 69 are threaded to the rod 65 within the chamber 67, to prevent the lower end of the rod 65 being withdrawn through the perforation in the cap 66. The supplemental weight 64 may thus be employed to support the weight 63 through the rod 65, and to withdraw or partially withdraw the weight 63 from the casing 60 as shown in Fig. 7. Also the weight 64 may be lowered so as to rest upon and add its weight to that of the weight 63, due to the rod 65 being forced down into the chamber 67, as shown in Fig. 6.

The upper end of the weight 64 is attached to a wire cable or chain 74, which passes over an idler pulley 70 and thence over a pulley 71 mounted loosely upon the shaft 56, and thence passes to a drum 72 mounted loosely upon the shaft 31. The wire cable 74 makes several turns around the drum and has one end attached to said drum. A spiral spring 85 has one end attached to the drum 72 and its opposite end attached to a hub 73 attached rigidly to the shaft 31. The spiral spring is designed to resiliently take up the slack in the cable 74 and wind the slack upon the drum 72 when the X-ray tube is moved toward the plate cabinet 16, and to yield cable by unwinding it from the drum 72, when the X-ray tube is moved away from the plate cabinet. A toothed clutch member 86 on the hub 73 is adapted to be clutched rigidly to the drum 72 by means of a tooth or latch 87 carried by a small hand lever 75 pivotally attached to the drum 72, to thereby lock the drum 72 in operative relation to the shaft 31 and plate cabinet 16 after each adjustment of the X-ray tube to or from the plate cabinet. A set screw 76 enables the weight 63 to be locked rigidly to the housing 60. A set screw 77 enables the X-ray tube carriage to be locked rigidly to the tubular member 47. When the set screws 76 and 77 are released, and the drum 72 is clutched to the hub 73, the combined effect of weights 59 and 63 in the position of the weight 63 shown in Fig. 5 is just sufficient to counterbalance the weight of the X-ray tube carriage and parts carried thereby causing them to hold any position to which they may be adjusted. The lifting of the weight 63 from its position of rest within the housing 60, as shown in Fig. 5 to the position shown in Fig. 7 causes the X-ray tube carriage to become of lighter weight than the weight 59, and hence to rise. The addition of the weight 64 to that of 63 as shown in Fig. 6 causes the X-ray tube carriage to prevail over the weight 59 and to descend. Hence when the operator grasps the handle 37 and depresses the plate cabinet, the wire cable is unwound from the drum 72 until the weight 64 rests upon the weight 63, causing the X-ray tube carriage to descend until the X-ray tube becomes central with the plate cabinet, where the weights 63 and 64 separate and the parts become stationary. When the handle 37 is employed to elevate the plate cabinet the wire cable draws the weight 64 upwardly and also lifts the weight 63 partially out of its casing 60, which causes the X-ray tube carriage to move upwardly until the X-ray tube again becomes central with the plate cabinet and the weight 63 again rests upon the bottom of the housing 60. The air vent 62 limits the rate of flow of air to and from the casing 60, and thereby prevents rapid movement of the X-ray tube carriage in upward or downward direction and

also cushions it against any jar or vibration when coming to a position of rest.

A latch or bolt 95 is mounted in a housing 96 carried by the base member 40, and is spring actuated to automatically engage with one or other of the perforations 39 in the track 38. A pivotally mounted foot lever 97 is adapted to be actuated to withdraw the bolt 95 from engagement with the perforation in the track 38 when it is desired to adjust the X-ray tube to a new position relative to the plate cabinet.

The sensitive plates may be mounted in plate holders and supported in any desired manner within the plate cabinet 16. A cable 90 containing a plurality of electrical conductors is employed to electrically actuate mechanism to shift the plate holders within the plate cabinet, and to energize or to shift the X-ray tube, and to connect said electrically actuated mechanism with a push bottom close to the apparatus and also a push bottom adapted to act as a remote control therefor. In order to support the cable 90 relative to the frames 15 and 18 I provide a metal tube section 91 attached by means of a bracket 92 to the cross bar 29 of the frame 15, and a tube section 93 telescopically adjustable relative to the tube section 91, and attached rigidly to the cap 49 of the frame 18, so that movement of the X-ray tube toward or from the plate cabinet causes the tube sections 91 and 93 to move telescopically and relatively, and enables said tube sections 91 and 93 to support the cable 90 without injury thereto.

The apparatus herein shown and described is capable of considerable modification within the scope of the claims without departing from the spirit of my invention.

What I claim is:

1. Radiographic apparatus comprising a plate cabinet supporting member, a plate cabinet adjustable vertically upon said cabinet supporting member, an X-ray generator supporting member, an X-ray generator adjustable vertically upon said generator supporting member, means to substantially counterbalance the weight of said plate cabinet and X-ray generator and cooperating parts upon said supporting members, and supplemental weights one of which is adapted to be actuated for automatically causing one of said vertically adjustable members to move vertically in the same direction when the opposite member is manually adjusted.

2. Radiographic apparatus comprising a plate cabinet supporting member, a plate cabinet adjustably mounted upon said supporting member, means to substantially counterbalance said plate cabinet, an X-ray generator supporting member, an X-ray generator carriage having an X-ray generator mounted thereon and adjustably mounted upon said generator supporting member, means to substantially counterbalance said X-ray generator carriage and cooperating parts, a supplemental counterweight housing having a restricted air port leading thereto carried by said co-operating parts, a major supplemental counterweight movable into and out of said housing, a minor supplemental counterweight connected to said major supplemental counterweight and adapted to be moved to rest upon said major supplemental counterweight, and to support its own weight independently of the major supplemental counterweight, and to support its own weight and also that of said major supplemental counterweight, and means adjustably connecting said minor supplemental counterweight to the counterbalancing mechanism of said plate cabinet.

3. Radiographic apparatus comprising a plate cabinet supporting member, a plate cabinet adjustably mounted upon said supporting member, means to substantially counterbalance said plate cabinet, an X-ray generator supporting member, an X-ray generator carriage having an X-ray generator mounted thereon and adjustably mounted upon said generator supporting member, means to substantially counterbalance said X-ray generator carriage and co-operating parts, a supplemental counterweight housing having a restricted air port leading thereto carried by said cooperating parts, a major supplemental counterweight movable into and out of said housing, a minor supplemental counterweight adapted to be connected to said major supplemental counterweight and movable to rest upon said major supplemental counterweight, and to support its own weight independently of the major supplemental counterweight, and to support its own weight and also that of said major supplemental counterweight, a resiliently actuated drum, a flexible connection leading from said minor supplemental counterweight to said drum, a driven member driven in unison with said plate cabinet counterbalancing means, a clutch member operable to clutch said drum in driving relation to said driven member.

4. Radiographic apparatus comprising a plate cabinet supporting member, a plate cabinet adjustably mounted upon said supporting member, an X-ray generator supporting member, an X-ray generator carriage and co-operating parts having an X-ray generator mounted thereon and adjustably mounted on said X-ray generator member, a counterweight housing carried by said co-operating parts and provided at its lower end with an air port, a major counterweight movable into and out of said counterweight housing and adapted to have its movement pneumatically cushioned within said counterweight housing, a minor counterweight adapted to be connected to said major counterweight, adapted to rest upon said major counterweight, adapted to be supported independently of said major counterweight and adapted to support the weight of said major counterweight, and means to connect said minor counterweight to said plate cabinet to move said minor counterweight upwardly when said plate cabinet is moved upwardly, and to move said minor counterweight downwardly when said plate cabinet is moved downwardly.

5. A first substantially counterbalanced member, a second substantially counterbalanced member, a supplemental counterweight housing carried by said second substantially counterbalanced member and provided with an air port, a major supplemental counterweight movable into and out of said counterweight housing, a minor supplemental counterweight adapted to be connected to said major supplemental counterweight, adapted to rest upon said major supplemental counterweight, adapted to be supported independently of said major supplemental counterweight and adapted to support the weight of said major supplemental counterweight, and means to connect said minor supplemental counterweight to said first substantially counterbalanced member for moving said minor supplemental counterweight upwardly when said first counterbalanced member moves upwardly and to move said minor supplemental counterweight downwardly when said first counterbalanced member moves downwardly.

6. Radiographic apparatus comprising a plate cabinet supporting member, a plate cabinet adjustable vertically upon said cabinet supporting member, means to substantially counterbalance the weight of said plate cabinet, an X-ray generator supporting member, an X-ray generator adjustable vertically upon said generator supporting member, means to substantially counterbalance the weight of said X-ray generator and cooperating parts and means comprising supplemental weights one of which when in contact with cooperating parts of said X-ray generator insures the counterbalancing of said X-ray generator and cooperating parts, the other of said weights being connected to said plate cabinet and adapted to be actuated by the manual adjustment of said plate cabinet for insuring automatic movement of said X-ray generator in the same direction as said plate cabinet.

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